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**LANGUAGE TRANSFER BETWEEN ENGLISH AND GERMAN: A PHONETICS-
BASED STUDY OF INTERACTIONS BETWEEN SPEAKERS' NATIVE AND
SECOND-LANGUAGE VOWEL SYSTEMS**

by

EMELIA PAUA BENSONMEYER

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**PROFESSOR MA
PROFESSOR HOLLIDAY
PROFESSOR DIERCKS**

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Abstract

The present study addresses language contact processes in which the phonetic systems of the languages that bilinguals speak interact. Specifically, language transfer with respect to English and German was examined, focusing on native German speakers (L1) who learned English as a second language (L2). It employed as its central method an analysis of their vowel systems, both language-specifically and cross-linguistically. Extralinguistic variables were also considered, ranging from speakers' age of acquisition (AOA) of English to their length of residence in an English-speaking environment to their consideration of home. Results indicated statistically significant differences between speakers' production of /ɪ/ and /ʊ/ for English and German, following a general trend of English productions as lower and more fronted than their German counterparts. Wide variability among participants produced inconsistent results, underscoring the complexity of speakers' vowel systems as a result of their interactions with extralinguistic variables.

Keywords: Bilingualism, Phonetic Drift, Vowel Systems, English, German

Language Transfer Between English and German

Language transfer among bilinguals is a relatively well-studied phenomenon in which speakers' language-specific phonemic inventories interact. Forward transfer, the process by which a speaker's native language (L1) influences, or 'colors', their second language (L2), has been studied rather extensively (Flege et al., 1997; Flege et al., 1999; Fought, 1999; Hopp & Schmid, 2013). The opposite direction of this process in which the L2 influences the L1, known as backward transfer, is considerably less prominent in the literature. Specifically, the relationship between German and English with respect to backward transfer has very limited presence. In an attempt to address this lack of research, this study examined the degree and directionality (i.e., forward or backward) of effects of language transfer among native German speakers who learned English as a second language. This (perhaps bidirectional) transfer is not the only type of transfer; speakers' linguistic systems are complex and interact at a number of levels. With respect to phonetic transfer between speakers' L1 and L2, however, these effects were measured in the current study using speakers' vowel systems, examining both their first and second formant values for each monophthong (i.e., a vowel that has one acoustic quality, as distinguished from a diphthong). Formants are resonant overtones, measured in Hertz, which indicate a vowel's relative height and frontedness (Ladefoged, 2015). The first formant (F1) has an inverse relationship with height; a low F1 value indicates a high vowel, whereas a high F1 value indicates a lower vowel. The second formant (F2) has a direct relationship with frontedness; a low F2 value indicates a backed production, whereas a high F2 value indicates a fronted production. At this level, backward transfer is known as phonetic drift.

Differences in speakers' vowel systems were analyzed with respect to speakers' age at acquisition of English, proficiency in English, cross-linguistic similarities, and other

extralinguistic factors such as speakers' attitudes towards English and media consumption. In order to find evidence of phonetic drift, speakers' German vowels would be approximating those of English. Their vowel productions were analyzed with respect to the vowels' cross-linguistic counterparts within individuals as well as across each group.

A number of research questions stem from this area within bilingualism. Principal among them are the questions of whether or not, and to what extent, forward transfer and/or backward transfer take place within speakers' vowel systems. This study also addressed where these effects are taking place with respect to individual vowels cross-linguistically. Additionally, it addressed whether the vowel productions were being merged into the same category or distinguished more from each other, based on their cross-linguistic similarities. Finally, it examined the extralinguistic factors mentioned above (e.g., age of acquisition, level of proficiency in English) to build connections between stages of bilingual learning with transfer effects, specifically as they related to phonetic drift.

The current study took as its central underlying model Jim Flege's 1995 Speech Learning Model. Its primary goal is to describe the process of language acquisition, specifically with respect to a speaker's second language. At its base, this model assumes that speakers' phonetic systems are adaptive over their lifetimes and that these phonetic systems are capable of reorganization when exposed to new sounds, such as those in a second language (Flege, 1995).

Numerous studies have examined the reasons driving foreign accents, with proposals ranging from neurological maturation (meaning that after a certain age, or critical period, speakers will be unable to attain completely native pronunciation in a foreign language) to inaccurate perception of sounds to interference from a speaker's L1. The Speech Learning Model (Flege, 1995) examined these proposals as well as the role of a speaker's age of acquisition,

focusing on speakers with extensive experience with their L2. It proposed two processes that may be occurring where sounds are not produced natively: assimilation and dissimilation.

Assimilation involves the convergence of sounds into the creation of a single phonetic category, triggered when speakers interpret sounds in an L2 as similar to (or allophones of) sounds in their L1. They therefore assimilate those L2 sounds into their production of the similar ones in their L1, producing nonnative elicitations. Dissimilation occurs when speakers discern a difference between sounds in their L1 and L2, exaggerating that difference in order to contrast the sounds cross-linguistically, again producing nonnative pronunciation. Both of these processes are influenced by perceptual and motor output constraints, which are influenced by the speaker's L1.

Flege (1995) proposed a number of hypotheses of the Speech Learning Model, several of which were used as the foundation for the predictions in the current study:

1. If speakers perceive phonetic differences between L1 and L2 sounds, they will be able to establish new phonetic categories for those L2 sounds.
2. The easiest sounds for L2 learners to produce in a native-like manner are those that differ the most significantly from sounds in their L1.
3. Speakers become less able to perceive and produce differences in L2 sounds (specifically those that contrast in the L2 but not the L1) as their age of acquisition of the L2 increases.
4. Assimilation may occur in which a merged category is produced, containing sounds from the L1 and L2, when sounds are perceived as equivalent cross-linguistically.
5. Bilinguals' production of sounds may not be the same as that of monolinguals due either to dissimilation in an effort to preserve contrast or to a representation of the sound based on different features.

Flege (1995) also discussed the bidirectional nature of cross-language phonetic interference. That is, there can be not only interference in L2 production from the L1, but also interference in L1 production from the L2. This process was a central focus of the current study.

The fifth hypothesis listed above concerns itself with Dispersion Theory, which states that speakers seek to maximize distance between phonemes within their phonemic inventories in order to minimize the chance of misperception (Liljencrants & Lindblom, 1972). However, different languages have different phoneme inventories. Specifically with respect to vowels, which are the focus of the current study, Ann Bradlow examined the acoustic vowel spaces of Spanish and English (1994). Because vowel inventories are language-specific rather than universal, speakers may modify and/or expand their vowel spaces under circumstances in which their speech would otherwise be confusing or subject to conflation of sounds. The acoustic realization of vowels is thus dependent on the language's inventory size. As a way to account for this, Bradlow (1994) proposed the notion of a language-specific base-of-articulation approach in order to account for language-specific differences in vowel production. Of course, although vowel spaces are generalized within languages, inter- and intra-speaker variation plays a large role as well (Jongman et al., 1989) and must be considered in analysis of speakers' vowel spaces within languages.

Such variation has been examined in a number of studies. Mayr et al. (2017) studied the effects of language contact and bilingualism among speakers of English and Welsh in Wales, looking at the influence of environment (monolingual or bilingual) and linguistic background on speakers' pronunciation of monophthongs, focusing on variation in their English and Welsh. Drawing from prior research, they asserted that the phonetic systems of bilinguals are separate, but still interact due to cross-linguistic contact. Generally, no differences were found across

language groups in terms of the production of English vowels. Welsh and English distinguish certain language-specific categories where specific differences arise, but where the languages are similar, there are no differences cross-linguistically. This suggested that where the languages are similar, speakers have only one phonetic system as a result of convergence (this is a case of assimilation, as posited by Flege (1995)).

Similar findings related to language transfer have been echoed and extended in a number of studies. Fought (1999) investigated whether any sound changes that are taking place in the California Anglo Dialect of English are also taking place in the Chicano English spoken in LA. She discussed this through the framework of Accommodation Theory, which states that people in contact with speakers of other dialects assimilate their language to the language of those speakers (Giles, 2016). Her focus was on /u/-fronting, a phenomenon documented as originating in the California Anglo Dialect in which the F2 value of /u/ is increasing, resulting in a more fronted production. /u/-fronting provides a quantitative measure to consider the idea that majority sound changes may be influencing minority communities. Fought also looked at social factors such as gang status, gender, and social class ranking to determine any extralinguistic factors that may be influencing these changes. Ultimately, she found that gang affiliation correlated with a relatively low degree of /u/-fronting, whereas middle class correlated with it at a higher degree. This correlation was, however, confounded by social class and gender. Generally, not being associated with a gang played a more significant role for women than it did for men. This study's methods of analyzing the formant values for a particular vowel within a social group are similar to those employed in the current study.

Because the current study concerns itself with the interaction of English and German, several studies were considered that also concerned themselves with the interaction of these two

languages. For instance, Bohn & Flege (1992) studied vowel production by adult German learners of English as their L2, evaluating pronunciation based on whether the vowel in English was cross-linguistically similar or different from their native vowel system. Their central research question regarded the effect of the amount of L2 experience on speakers' production of L2 vowels, relative to L1 cross-linguistic counterparts. They sought to examine whether there was an influence of amount of exposure to the L2 on speakers' production of L2 sounds, finding that among their speakers, it was possible for adults to learn to produce a new phonetic category, specifically when the phonemes involved were not shared across the languages. This follows Flege's Speech Learning Model (1995), which suggested that phonetically dissimilar sounds are the easiest for nonnative speakers to master.

Similar findings came out of Flege et al.'s (1997) study on the effects of experience on non-native speakers' production and perception of English vowels in which native German speakers were examined. In this study, native English speakers ranked non-native speakers' productions of vowel contrasts /i/-/ɪ/, /ɛ/-/æ/ in terms of their degree of perception, with the result that speakers who had had more experience with English were able to produce these contrasts with greater accuracy than those with less experience. Among native German speakers in particular, more experienced speakers of English were better able to produce /æ/ more accurately than speakers with less experience. This is because /æ/ does not exist in German, but with more exposure to English, speakers were both better able to perceive and produce this vowel. This study also addressed the role of age of acquisition (AOA) of English; as AOA increased, vowel production accuracy decreased. Although this study addressed some interactions of German and English, specifically those with an L1 of German and L2 of English, it left gaps in the literature.

The current study attempted to fill some of these gaps, addressing not only the influence of German on English, but also the reverse influence of English on German.

Although the majority of language transfer studies have concerned themselves with forward transfer (in which the L1 influences the L2), there is a growing body of literature concerning itself with the reverse process in which the L2 influences the L1, known as backward transfer (Cook, 2003) or, at the phonetic level, phonetic drift (Chang, 2010). Kartushina et al. (2016) conducted a literature review of studies with this focus. Generally, this review found that more experience with a speaker's second language causes greater influence on their native language. The paper examined the factors involved in language transfer and how they are intertwined, and attempted to separate the examined studies into groups depending on the most salient factor. It introduced the idea that after only a short period of time with the L2, the L1 production can be affected in terms of phonetics and lexical items (Chang, 2010). Higher-level transfer effects have been shown to occur after prolonged study of the L2 (i.e., years).

Kartushina et al.'s (2016) study also evaluated the literature through the lens of Flege's 1995 Speech Learning Model. This model assumes the view that bilinguals do not necessarily have two monolingual linguistic entities, but rather one overarching category that comprises both. This is not the case for simultaneous bilinguals, who keep separate phonetic systems for each language, reflective of the monolingual systems within each. This is reflective of another part of Flege's (1995) Speech Learning Model, which suggested that because the simultaneous bilinguals' phonetic systems are not fully developed, they are better able to keep them separate as they are growing.

With respect to exposure to the L2, studies have generally found that more experience with the L2 causes greater influence on the L1. However, Kartushina et. al's (2016) article also

addresses the discrepancy between L2 exposure and production and how these interact, suggesting that it is possible that L2 production (and not only exposure) is required in order for backward transfer to occur. In order to study backward transfer, several methodologies were employed, including production latencies, acoustic analyses of L1 productions, and goodness ratings (done by native speakers). Factors influencing transfer included L2 age of acquisition, pronunciation skill and proficiency, stage of L2 learning, immersion in an L2-speaking country, amount of L1 use, and cross-linguistic similarities with respect to phonemes and words.

Studies have also addressed individual differences. In terms of age of acquisition, late bilinguals have shown more backward transfer than early bilinguals (Baker & Trofimovich, 2005; Flege, 1999). That is, the earlier a speaker begins to learn an L2, the less likely a foreign accent is to emerge because it is more likely that the speaker will be able to keep the phonetic systems of each language separate, even though the inventories exist in a common phonological space (Barlow, 2014; Peeva et al., 2010). Therefore, a correlation has been found in which the later a speaker's age of acquisition is, the more pronounced their foreign accent will be, due to a decreased ability to keep the phonetic system of each language separate. This follows a basic tenet of Flege's (1995) Speech Learning Model and lies at the foundation of a number of other studies (Baker & Trofimovich, 2005; Flege, 1987). Late bilinguals have shown to be less able not only to produce, but also to perceive differences in sounds between L1 and L2, which prompts assimilation, in turn blocking L2 category formation (Kartushina et al., 2016). Therefore, because late bilinguals have shown to perceive similar sounds as parts of the same phonetic category, they produce them in the same way, using L1 phonetic categories to approximate similar L2 sounds (as evidenced in Guion, 2003). This entails applying the phonological rules and systems of the L2 when speaking the L1. These changes can either be

deflecting from nonnative sounds present in the L2 or drifting towards phonemes in the L2. It is possible that early bilinguals tend to engage in deflection more, whereas late bilinguals tend to assimilate sounds in L1 to be more like those in their L2. Late bilinguals have also been shown to merge sounds that share cross-linguistic similarities to create one linguistic category that applies to both languages, which leads to productions that differ from monolingual speakers in each language. This is part of a process in which late bilinguals make associations between sounds in the L1 and L2, using sounds from their L1 in their L2 production (a case of forward transfer). This can be influenced by their age and their perception of the L2 sounds.

L2 proficiency is another factor influencing language transfer. In Kartushina et al.'s (2016) study, 'proficiency' was used as a measure of pronunciation skill in the L2. Generally speaking, if a bilingual is not proficient in pronunciation in the L2, there will be no effect on their proficiency in their L1. This suggests that bilinguals with high proficiency in the L2 drift towards L2 phonetic categories, thereby accenting their L1 with their L2. Amount of use of each language plays a significant role here: if L2 use is dominant, L1 categories are likely to drift towards similar L2 ones. However, L1 categories are sometimes deflected in order to be distinguished from the L2. Whether or not the speakers live in an immersive environment (of the L2) could be a key factor for this process, though it has not been studied extensively.

Speakers with only novice levels of experience in the L2 have also demonstrated backward transfer. This can occur after as little as one hour of production training with nonnative vowels, according to a study with native English speakers and French vowels (Kartushina & Frauenfelder, 2013). These speakers showed more phonetic drift in their L1 vowel productions after this training towards vowels in the L2. In fact, they showed more phonetic drift than more experienced bilinguals. Similar effects were found by Chang (2010) who studied native English

speakers learning Korean as an L2, finding that experience with Korean very quickly influenced their English production. Here, Chang found assimilation effects to phonetic properties of Korean in which speakers were converging cross-linguistically similar phonemes into the same phonetic category. Specifically with respect to voice onset time (VOT) and fundamental frequency (F0), he found lengthening of English voiceless stops and raising of F0 onset following English voiced and voiceless stops. More generally, females' English vowels were all raised, assimilating towards the overall higher vowel system of Korean as compared to English. This may have to do with novelty bias, although this does not align with previously stated findings that greater L2 proficiency correlates with L2-accented speech in the L1.

Phonetic drift has been further analyzed in the case of native bilinguals who learned English as a third language (L3) (Kartushina & Martin, 2019). Kartushina and Martin's (2019) study focused on Basque-Spanish bilingual adolescents who learned English as an L3 through an English-immersive two-week long study abroad program in the Netherlands. This study aimed to address whether foreign language learning affects bilinguals' production, which factors influenced this, whether a study abroad English program was effective in improving the pronunciation of L3-vowels in the short and long term, and whether there was a relationship between the degree of change in native production and improvements in L3 production. Also using as its framework Flege's 1995 Speech Learning Model, they examined the cross-linguistic processes of assimilation and dissimilation as they related to the speakers present in the study. Immediately after intensive English exposure, participants' native vowel productions were influenced, evidencing assimilatory acoustic drift in each of their native languages in the direction of the English vowel system. However, without continued English exposure, these assimilatory effects began to fade. This study demonstrated the speed with which assimilation

and ensuing phonetic drift can occur and, likewise, the speed with which these processes can disappear.

Of course, all of these findings are dependent on the bilinguals' relative uses of their L1 and L2. If speakers live in immersive environments in which their L2 is spoken and they hardly use their L1, there may be strong cases of backward transfer. If a speaker uses their L1 more than their L2, forward transfer may be more prevalent. Both of these processes may occur together, creating one linguistic category that encompasses the (merged) phonetic systems of both languages. Finally, extralinguistic factors have been shown to interact with transfer effects including formality of speech, in which it has been shown that language transfer is less prevalent in formal speech than casual, as well as individual differences. Although forward transfer is more common, it is interesting to look at backward transfer because it is less grounded in research and because it is intertwined with so many other linguistic processes related to language acquisition and bilingualism.

Further language contact effects were studied by Lee and Iverson (2012). This study examined the vowel systems among native Korean-English bilingual children, measuring them in terms of their first and second formant values and trajectories as well as duration. Central research questions considered were (1) whether the vowels of Korean-English bilingual children were different from those of their monolingual counterparts, and if so, how; (2) whether Korean-English bilingual children established fully distinct vowel systems for each language; and (3) which mechanisms they employed. In terms of mechanisms, Lee and Iverson were referring to the processes of assimilation and dissimilation, both of which produce nonnative-like speech in each language. Findings showed that for the most part, vowel productions within each language were similar to those of monolinguals for each language (Flege et al., 2003). Exceptions to this

pattern were the high- and mid-back vowels /u/ and /o/ in Korean (which also exist in English), which revealed some influences from English due to their higher F2 values. These findings contrast with those of Baker and Trofimovich (2005) because not much evidence of phonetic drift was found. However, Baker and Trofimovich studied speakers between 7 and 13 years of age, after they had fully acquired their L1, rather than Lee and Iverson's study, which looked at children 5 and 10 years old. Speakers in Lee and Iverson's study were generally able to differentiate cross-linguistically similar sounds, indicating that they had formed separate phonetic systems for each language.

There are two main methodologies employed in many of the studies listed thus far. The first is the monolingual comparison approach, in which speakers' phonetic systems in their L1 and L2 are compared to that of monolinguals in the corresponding language. This is a useful method of ascertaining whether speakers are conforming to or deviating from the average productions in each language, whether as a result of forward or backward transfer through assimilatory or dissimilatory methods (Chang, 2010; Flege et al., 2003; Kartushina & Frauenfelder, 2013; Kartushina & Martin, 2019). The other common method is the shared-separate approach, in which the focus of the study is to determine whether speakers' phonetic systems for each language are separate from one another or whether they exist together under one overarching system. This method is applied when examining the role of cross-linguistically similar sounds between a speaker's L1 and L2 (Flege, 1987; Guion, 2003). Yet another approach involves the combination of both of these methods in which cross-linguistic similarities are taken into account in order to examine the merging or distinctiveness of speakers' phonetic systems, and bilingual speakers' phonetic systems are also compared to those of monolinguals in each corresponding language. A number of studies have adopted this approach in order to attain a

more well-rounded account of the effects of language contact (Lee & Iverson, 2012; Tuscha & Schmidt, 2018). The current study employed this combination of methods in order to evaluate the role of cross-linguistic similarity between German (speakers' L1) and English (speakers' L2) as well as age of acquisition of English and other extralinguistic factors to determine whether they maintained separate or merged phonetic systems. Additionally, speakers' vowel systems were compared to average values for monolinguals of English and those of German in order to gain a sense of the degree of difference or similarity between the bilinguals studied and monolinguals within each language. This provided a measure of the directionality of any transfer effects observed; that is, whether speakers' L1 influenced their L2 or vice versa—or a combination of both directions.

Several hypotheses were proposed based on the literature reviewed, drawing primarily from Flege (1995). These hypotheses were concerned namely with the effect of linguistic and extralinguistic variables on speakers' production of vowels; that is, whether factors such as cross-linguistic similarity and age of acquisition correlated with assimilation or dissimilation within phonetic categories. Principally, it has been suggested that as age of acquisition increases, so will assimilation, and cross-linguistically similar phonemes are the most difficult to dissimilate. The following hypotheses exemplify these claims:

1. If speakers are able to discern a difference between specific vowel phonemes in English and German, they will dissimilate these vowels on a language-specific basis.
2. The English vowel phonemes that are produced in the most native-like manner will be those that differ the most from the vowel phonemes of German. That is, vowel phonemes that are similar (or even identical, in terms of IPA symbol) will be much more difficult for German speakers to produce in a native-like manner in English.

3. Speakers who learned English at a later age will have less native-like English speech than those speakers who began to learn English at a younger age.
4. For vowel phonemes that speakers perceive as similar across German and English, they will have a merged phonetic category to account for these phonemes (this is a case of assimilation).
5. Speakers' productions of vowel phonemes may differ from native speakers of English and of German due to dissimilation in an effort to enhance contrast between cross-linguistically similar sounds. However, this also may prompt assimilation (as proposed in hypothesis #4).

These last two hypotheses evaluate opposite phenomena (i.e., assimilation and dissimilation).

Extralinguistic variables were assessed in the present study in order to draw parallels with the occurrence of each of these processes. In line with these hypotheses, special attention will be paid to vowel phonemes that exist in both German and English. These similar vowel phonemes will be assessed as compared to one another based on their shared IPA symbols: /i, ɪ, ε, ɔ, ʊ, u/.

Method

Participants

In order to evaluate transfer effects between English and German, native German speakers who learned English as a second language were chosen as speakers for the current study. Due to the relatively limited population of this demographic in the area surrounding the lab, the age of acquisition of English was not restricted, meaning that this factor varied from 5 to approximately 12 years. Because the population was so limited, recruitment was not random.

Rather, all 11 participants were recruited via emails to German faculty members to identify speakers who met these criteria, more demographics of whom are found in Table 1.

Table 1.

Speaker Demographics.

Speaker	Gender	City of Origin	Age of Acquisition of English (AOA)	Length of Time Spent Learning English (years)	Length of Residence in English-Speaking Environment (years)	Length of Residence in German-Speaking Environment (years)	English: German used Daily (%)
1	M	Bern, Switzerland	12	50	35	31	70:30
2	M	Vienna, Austria	5	45	22	31	98:02
3	F	Frankfurt, Germany	10	44	28	24	50:50
4	M	Mannheim, Germany	6	15	0.25	21	70:30
5	F	Gara, Germany	8	13	4	16	98:02
6	F	Brandenburg, Germany	6	10	0.25	22	90:10
7	F	Carinthia, Austria	6	11	0.25	20	70:30
8	F	Styria, Austria	6	12	0.25	22	95:05
9	M	Dorsten, Germany	10	32	12	31	80:20
10	M	Klagenfurt, Austria	12	30	17.5	38	85:15
11 ¹	M	Portugal	12	12	1	4	95:05

¹ This speaker was born and raised in Portugal until the age of 15; however, his mother is from Düsseldorf and his father is from Saarbrücken. He identifies his first language as German and his second as English, though he does speak Portuguese fluently. He resided in Berlin from the age of 15 until 19.

Materials

Speakers were asked to read two word lists, one in German and one in English. German words elicited were taken from Kohler (1990) in order to obtain speech samples containing all of the monophthongs of German (with the exception of /ə/, which only occurs in unstressed positions). The English words elicited were taken from Hillenbrand et al. (1995) in order to obtain speech samples containing all of the monophthongs of English (with the exception of /ə/, which only occurs in unstressed positions) as well as to limit the phonological contexts in which they occur. All elicited words are presented in Table 2.

Table 2.

Elicited words for vowel measurements.

Vowel	English	German
/i/	heed	bieten (<i>to offer</i>)
/ɪ/	hid	bitten (<i>to beg</i>)
/ɛ/	head	Betten (<i>beds</i>)
/ɔ/	hawed	Botten (<i>boots</i>)
/ʊ/	hood	Butter (<i>butter</i>)
/u/	who'd	sputen (<i>to hurry</i>)
/ɑ/	hod	--
/a/ ²	--	hatten (<i>had</i>)
/æ/	had	--
/ʌ/	hud	--
/e/	--	beten (<i>to pray</i>)
/ɛ:/	--	bäten (<i>begged</i>)
/y/	--	hüten (<i>to tend</i>)
/ʏ/	--	Hütten (<i>huts</i>)
/ø/	--	Goethe
/œ/	--	Götter (<i>gods</i>)
/a:/	--	baten (<i>begged</i>)
/o/	--	boten (<i>offered</i>)

² Although they are not represented by the same IPA symbol, /ɑ/ and /a/ were used as a point of cross-linguistic comparison due to their proximity in an average speaker's vowel space. They are represented by the same ARPAbet symbol used for extraction and normalization procedures.

These elicitation data align with the IPA vowel charts of American English (Mainstream US English (MUSE)) and Standard High German, presented in Figure 1:

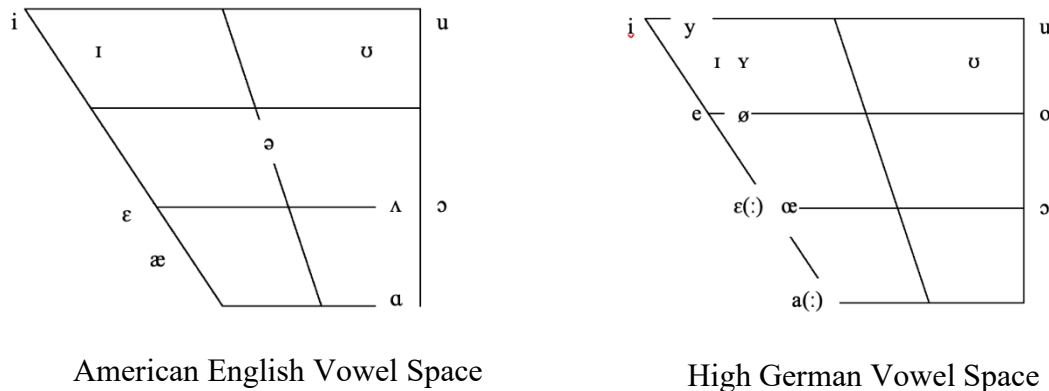


Figure 1. Reported vowel charts of American English and High German.

Additionally, a 13-question questionnaire was completed in the form of an interview. The objective of this questionnaire was to obtain additional information about speakers' linguistic backgrounds and to gain insight into any factors that may have been influencing their speech production. A complete copy of this questionnaire can be found in Appendix A.

Procedure

Speakers participated in a one-time in-person interview that lasted approximately 30 minutes. This took place in a sound booth and was recorded with a Zoom H1n recorder and external microphone. Before the interview commenced, speakers were asked to read and sign an informed consent form outlining how their data would be used. Each interview began with a formal speech elicitation. This involved reading two series of words on cards (data from this were presented in Table 2). The German portion of the interview was conducted first and the rest took place in English. Each speaker was asked to read each series of words three separate times

with short pauses in between each word. In between each round, the cards were shuffled in order to eliminate any anticipatory bias.

Only formal speech was considered as a measure of speakers' vowel spaces. Although this does not accurately match speakers' vowel systems in more casual settings, it was used for clarity as well as accessibility in interviews. Thus, the analyses of the current study are limited because they only reflect speech that was carefully produced, rather than colloquial speech, which is much more commonly produced. Because the primary investigator is not a native speaker of German, no part of the casual interview was conducted in German as to avoid any priming effects within the speakers' language in order to accommodate the researcher's language skills in German. All participants were addressed in English for the duration of the interview. Thus, although accommodating effects were avoided within participants' speech, participants were also primed in an English-speaking environment. For this reason, each participant was asked to read each set of words three times in order to obtain at least three tokens of each monophthong in each language in order to obtain the most natural production of each vowel.

The only section of the interview that took place in German was the formal speech elicitation of German words. Following the formal speech elicitation described above, a series of questions were asked in English to obtain information with respect to the speaker's linguistic background. This was included in order to gain information on what may be explanatory variables influencing transfer effects that are taking place. Speakers were encouraged to speak freely, including any anecdotes or examples they felt relevant. Questions pertained to speakers' age of acquisition of English, the age that they moved to an English-speaking environment and how long they have resided in one, and their metalinguistic awareness of influences of their

German on their English and vice versa.³ Upon completion of each interview, speakers were given a debriefing document outlining more specific information relating to the objectives of the study.

Data Preparation

Each recording was uploaded as a .wav file and shortened into its German and English components, and the English component was further split into its formal and informal speech elicitations in order to simplify data formatting processes. Each of these English files was then formatted in a .TextGrid in Praat (Boersma & Weenink, 2018) in which each word was transcribed in orthography. This provided the correct format to run each .TextGrid file and its corresponding sound file through a forced aligner to extract the vowel formants, which were used as the primary measure of analysis.

Dartmouth Linguistic Automation (DARLA, Reddy & Stanford, 2015) was used as a forced aligner to extract F1 and F2 values for the English data at the midpoint of each vowel token. These generated data were then run through a Vowel Normalization and Plotting Suite (NORM, Thomas & Kendall, 2007), using the Labov (ANAE) speaker extrinsic model, in order to normalize for differences in speakers' vowel space sizes, which produced plots as well as F1 and F2 values for each speaker's vowel space. This model was chosen because it scales the original formant values, avoiding extra manipulation of the data. These normalized data were used in the analysis of the current study.

Because no program similar to the Dartmouth Linguistic Automation exists for German, a Praat script was run to extract formants at the midpoints of each vowel. This involved manual

³ A complete list of interview questions can be found in Appendix B.

segmentation of each German word elicited within a Praat .TextGrid, creating the proper format for the script to run. These data were normalized for size of speakers' vowel space (Thomas & Kendall, 2007) using the same Labov (ANAE) speaker extrinsic model as the English data.

Statistical analyses were conducted in order to examine whether there was statistical significance between speakers' English and German vowel spaces, specifically with respect to cross-linguistically similar sounds (i.e., those which share the same IPA symbols). These included dependent-sample t-tests between speakers' F1 for each German and English vowel, as well as between speakers' F2 for each vowel in each language. Additionally, in order to establish interaction with extralinguistic factors, bivariate correlations were conducted between the difference between speakers' F1 and F2 values for each vowel cross-linguistically and continuous variables such as age of acquisition of English, length of residence in German- and English-speaking environments, and ratio of German to English used on a daily basis. This correlation provided a basis upon which speakers could be grouped and compared to one another.

Results

Analyses were conducted in two separate steps: (1) a monolingual comparison, in which speakers' F1 and F2 values for each language were qualitatively compared to those values for monolinguals of English and monolinguals of German, and (2) a bilingual comparison, in which speakers' individual vowel systems were analyzed, in terms of their F1 and F2 values, to look for assimilatory and/or dissimilatory patterns among vowels that exist in both English and German as well as those that are language-specific.

Monolingual Comparisons

Because no data were collected from monolinguals for the purposes of the present study, already reported data in the literature were used. Therefore, no statistical analyses can be conducted because the monolingual data do not accurately align with that of the current study. That is, the reported data do not account for dialectal differences and are not normalized for size of vowel space. This limits the certainty with which phonetic drift can be tested because it is not an accurate point of comparison to evaluate the bilingual data to. However, the reported data can be considered to explore how much (or little) bilingual speakers approach native-like production values in their L2 in order to examine any indication of forward transfer or phonetic drift. Based on the literature reviewed and hypotheses proposed, it was expected that both of these processes would occur with cross-linguistically similar vowels that were assimilated, producing nonnative-like production for both languages.

One of the primary sources used for this comparison was Hillenbrand et. al (1995), who presented average formant values for English vowels among men and women (and children, though these data have been removed for the sake of relevance) from the upper Midwest. See Table 3 for a comparison of Hillenbrand et al.'s (1995) data to those from the current study.

Table 3.

Average formant values as presented by Hillenbrand et al. (1995) and the current study. Data measured in Hz.

Vowel	Hillenbrand et al. (1995)				BensonMeyer (2019)	
	F1 (Men)	F1 (Women)	F2 (Men)	F2 (Women)	F1	F2
/i/	342	437	2322	2761	357.73	2505.26
/ɪ/	427	483	2089	2530	477.71	2316.91
/ɛ/	580	731	1799	2058	681.75	1980.22
/æ/	588	669	1952	2349	793.62	1849.30
/ɑ/	768	936	1333	1551	705.55	1052.91
/ɔ/	652	781	997	1136	685.16	969.80
/ʊ/	469	519	1122	1225	473.71	1246.45

/u/	378	459	997	1105	371.95	1003.20
/ʌ/	623	753	1200	1426	738.17	1358.81

These data have been normalized using normalization software NORM (Thomas & Kendall, 2007) and plotted in Figure 2.

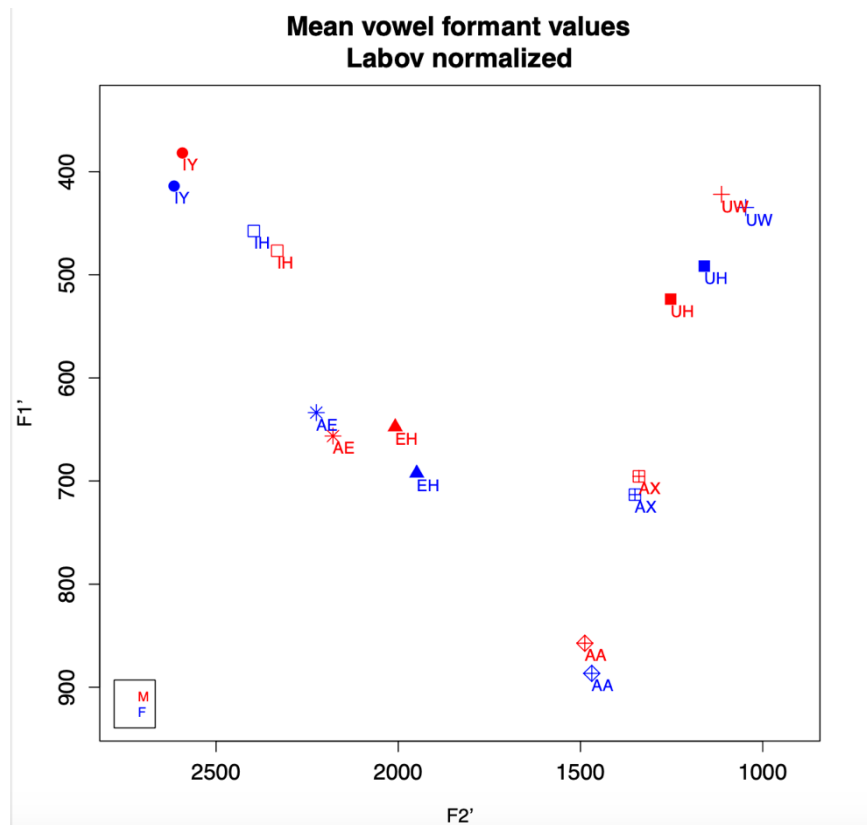


Figure 2. Average formants for English vowels (Hillenbrand et. al, 1995). Data measured in Hz.⁴

These data provide a point of reference for comparison to examine whether current speakers are approaching the average vowel space for a monolingual speaker of English. Data from the current study were normalized using the Labov (ANAE) speaker extrinsic model (Thomas &

⁴ ARPAbet conventions are used here and in plots throughout the present study. This is because the normalization software used does not accept data transcribed in IPA. A full translation of each ARPAbet symbol can be found in Appendix A.

Kendall, 2007) and presented in Table 3. These data are reflected in Figure 3 for easier descriptive analysis.

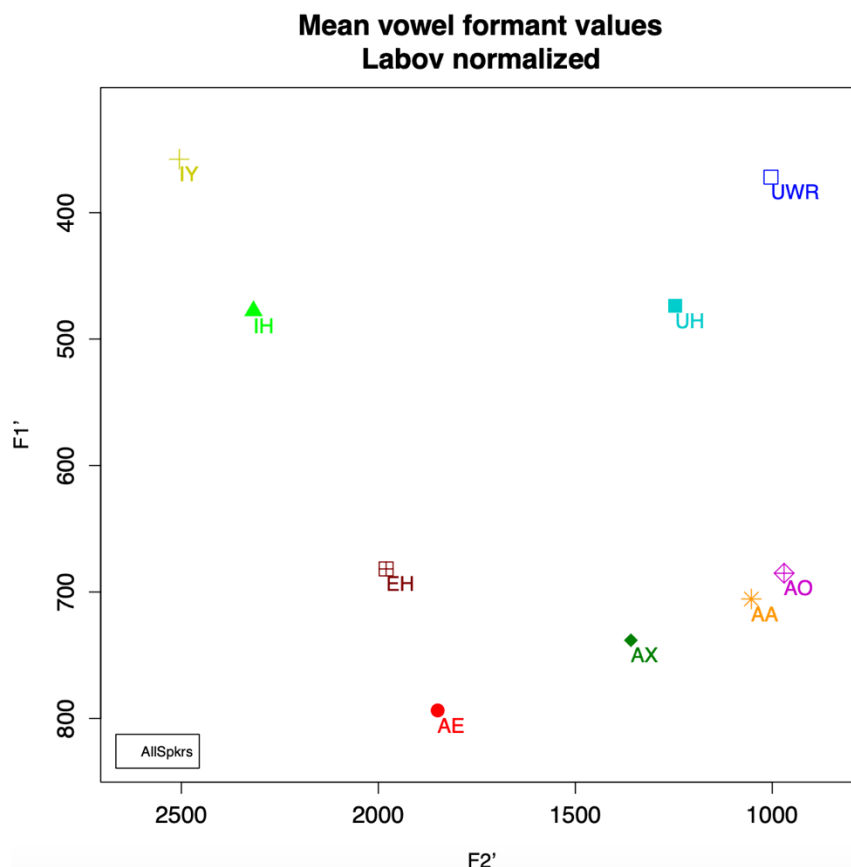


Figure 3. Average formants for English vowels. Data measured in Hz.

As indicated by the plot above, formant values for English vowels from the current study resemble those from Hillenbrand remarkably closely. The largest differences lie in the values for /æ/, for which speakers from the current study have a higher F1 (indicating a lower position in the vowel space) and a lower F2 (indicating a farther back position in the vowel space) than predicted by Hillenbrand et. al's data. /ɑ/ also differs to a greater degree from the values found by Hillenbrand, having a lower F1 (indicating a higher position in the vowel space) and a lower F2 (indicating a farther back position in the vowel space). This suggests forward transfer in which speakers' German is affecting their English. Additionally, the German vowel space is less dispersed than the English one due to a more crowded vowel inventory, leaving less space for

new sounds to be introduced. It is thus logical that speakers' production of /æ/ would begin to approximate that of another vowel; in this case, with a lower production than of English.

These similarities are interesting because they imply that speakers have relatively native-like production of English vowels. However, this cannot be stated so generally because of individual differences among speakers with respect to age of acquisition of English, length of residence in an English-speaking environment, ratio of German to English employed on a daily basis, and other extralinguistic factors. No further monolingual analyses were conducted for the purposes of the current study because the data employed were reported averages, rather than original data specific to this study. Although there appears to be no strong evidence of phonetic drift, it is impossible to make this claim given the limitations of the current study.

In order to carry out a comparison between the German vowel spaces of speakers in the present study and the average German vowel space, Pätzold and Simpson's (1997) study was used.⁵ Their data, compared alongside data from the present study, are presented in Table 4 (taken at the midpoint of each vowel production). These reported data (Pätzold & Simpson, 1997) were then normalized and plotted in Figure 4.

⁵ The vowels examined in this study do not correspond perfectly to those in the present study. Because the elicitation material for vowel production was collected from a separate source (Kohler, 1990), the IPA symbols are also slightly different, as evidenced by the following table (only those that differ are indicated below):

Pätzold and Simpson	/i:/	/y:/	/e:/	/ø:/	/o:/	/u:/
Present Study	/i/	/y/	/e/	/ø/	/o/	/u/

Table 4.

Average formant values as presented by Pätzold and Simpson (1997) and the present study. Data measured in Hz.

Vowel	Pätzold & Simpson (1997)				Vowel	BensonMeyer (2019)	
	F1 (Men)	F1 (Women)	F2 (Men)	F2 (Women)		F1	F2
/i:/	290	329	1986	2316	/i/	364.25	2162.93
/ɪ/	343	391	1803	2136	/ɪ/	426.03	1937.25
/y:/	310	342	1505	1667	/y/	354.81	1941.37
/ʏ/	374	406	1431	1612	/ʏ/	427.14	1689.81
/e:/	372	431	1879	2241	/e/	399.67	2224.90
/ɛ/	498	592	1639	1944	/ɛ/	621.05	1700.21
/ø:/	375	434	1458	1646	/ø/	416.25	1631.87
/œ/	437	509	1504	1767	/œ/	591.29	1586.22
/a:/	639	779	1225	1347	/a:/	829.19	1326.29
/a/	608	751	1309	1460	/a/	794.36	1345.62
/o:/	380	438	907	953	/o/	448.14	976.07
/ɔ/	506	573	1060	1174	/ɔ/	632.70	1037.85
/u:/	309	350	961	1048	/u/	391.09	1282.40
/ʊ/	382	450	1058	1184	/ʊ/	431.48	1036.18
/ɐ/	503	590	1372	1608	/ɛ:/	623.06	1825.36
/ə/	370	420	1521	1746			

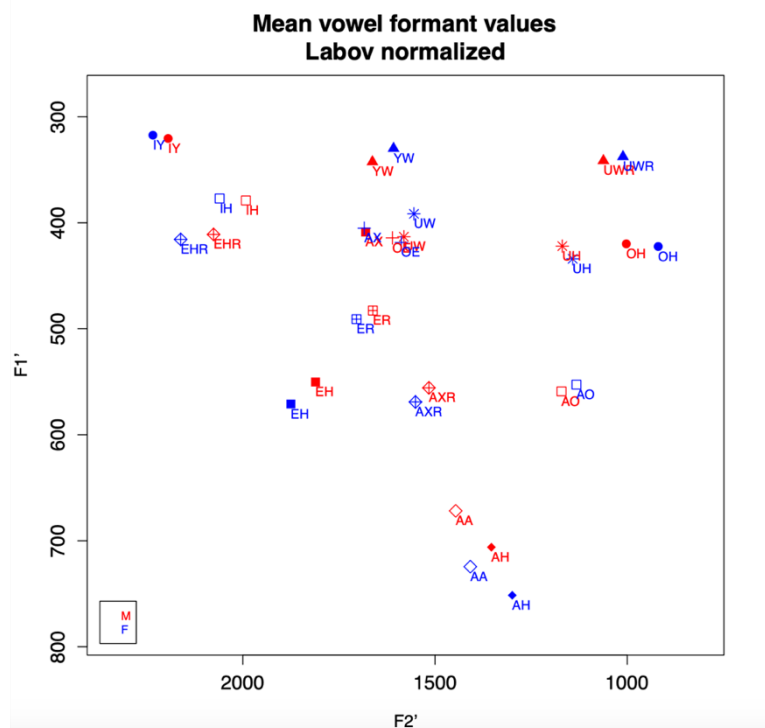


Figure 4. Average German formant values (Pätzold & Simpson, 1997). Females' mean values are represented in blue, males' mean values in red.

These data were then qualitatively compared to average normalized F1 and F2 values for each German vowel from the present study, presented in Table 4 and plotted in Figure 5.

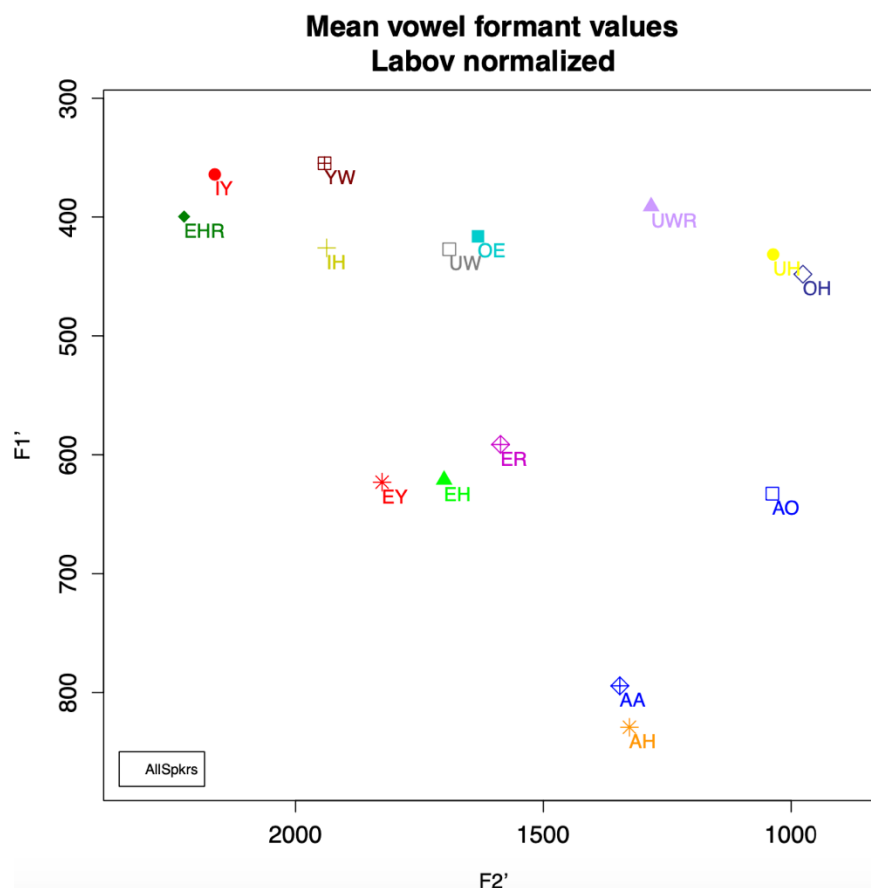


Figure 5. Average formants for German vowels. Data measured in Hz.

Despite minor differences (which could be due to inter-speaker variation and/or dialectal differences), all of the reported average values for German vowels are relatively similar to those found in the present study. The only larger observed difference between these two sets of data is the F2 value of /y/ (elicited in context /hytən/), which is much higher in the present study, therefore indicating a more fronted production. Data presented by Pätzold and Simpson (1997) exclude the vowel /ɛ:/ (elicited in the context /bɛ:tən/); however, based on strong similarities between the two data sets with the given data, one could assume that these values would be relatively similar as well.

This provides evidence of native-like production of all German vowels, perhaps with the exception of a more fronted /y/, which could be caused by dialectal differences or speakers' experience in English-speaking environments. However, because the present study did not have access to monolingual speakers of German for a more concrete point of comparison, no further analyses could be conducted to explore the level of production of native-like speech among the participants in the current study. The similarity between the reported data and the current study does, however, indicate a lack of phonetic drift because it does not appear that speakers' vowel productions are approaching average values for English, but rather keeping in line with reported German values. Although this could vary based on speaker demographics (whether individual or independent group-based), using the average values as reported by another study is not an accurate point of comparison for more specific differences. Therefore, this study focused primarily on the degree of difference within cross-linguistically similar vowels, rather than the directionality of the transfer effects due to a lack of availability of data.

Bilingual Comparisons

A bilingual comparison was conducted in order to determine whether assimilation or dissimilation was occurring among cross-linguistically similar vowels. For the purposes of this study, vowels that share IPA symbols were assumed to be cross-linguistically similar. Table 5 shows average F1 and F2 values for each cross-linguistically similar vowel in each language. This reflects initial examination without consideration of speaker demographics.

Table 5.

Mean F1 and F2 values for cross-linguistically similar vowels.

Vowel	English		German	
	Mean F1	Mean F2	Mean F1	Mean F2
/i/	361.80	2486.11	362.90	2158.22
/ɪ/	479.20*	2300.61**	423.80*	1948.68**
/ɛ/	682.04	1982.84	623.38	1691.44
/ɔ/	687.34	970.83	629.06	1034.21
/ʊ/	473.82**	1242.71**	430.77**	1036.79**
/u/	371.95	1003.20	393.91	1303.11

*Dependent samples t-test revealed a significant difference with cross-linguistically similar counterpart ($p < .05$).

**Dependent samples t-test revealed a highly significant difference with cross-linguistically similar counterpart ($p < .01$).

This table indicates significant differences, as established by dependent samples t-tests, between the English and German productions of /ɪ/ (F1: $t [10] = 2.68$, $p < .05$; F2: $t [10] = 3.84$, $p < .01$) and /ʊ/ (F1: $t [10] = 3.25$, $p < .01$; F2: $t [10] = 6.26$, $p < .001$). As represented by these values, both vowels were produced in English with higher F1 and F2 values, indicating both lower and more fronted productions than their counterparts in German. This indicates that speakers have established separate phonetic categories for the vowels /ɪ/ and /ʊ/. Speakers' English F1 and F2 values for these vowels, which were relatively higher than those for their German counterparts, also aligned with Hillenbrand et. al's (1995) data on American English vowels as they compare to Pätzold and Simpson's (1997) data on German vowels. Thus, this is a case of dissimilation in which speakers' English vowels are more closely approximating average vowels of English, whereas their German vowels are similar to average reported values for native speakers of German.

Apart from these two vowels, however, cases of assimilation were found, as indicated by a lack of significant differences between each overlapping vowel in English and German. That is, speakers had merged phonetic categories for the remaining cross-linguistically similar vowels /i/,

/ɛ/, /ɔ/, and /u/. Naturally, these differences varied based on individual and shared speaker demographics, which are discussed in more detail later in this paper.

Participant Characteristics

Due to the limited population from which speakers were recruited, it was difficult to control for age of acquisition of English. However, speakers were split into two groups on this basis: those who began to acquire English at the age of six or younger, and those who began to acquire English at an age greater than six. Several speakers reported beginning basic English lessons at or around the age of six, but not learning the language more intensively until age 11 or 12. For the purposes of this study, beginning English lessons were evaluated as speakers' age of acquisition (even if they were not able to speak at that age, they were consistently exposed to the language, which likely influenced the way that they acquired the language).

Bivariate correlations were conducted to examine whether there was any significant correlation between speakers' age of acquisition and F1 and F2 values cross-linguistically. Ultimately, no significant correlations were found with respect to these variables. Likewise, an examination of the data more descriptively as grouped into a categorical variable (i.e., $AOA \leq 6$ = low, $AOA > 6$ = high) versus a continuous one yielded no significant results. That is, the number and degree of statistically significant differences between cross-linguistically similar vowels as produced in each language, measured on a basis of F1 and F2 values, appeared to be relatively similar.

Average productions of each cross-linguistically similar vowel were examined in each language per speaker in order to see whether any independent groups could be established with respect to shared speaker norms in an attempt to contextualize data with extralinguistic variables

(even though a bivariate correlation with these factors yielded no significant results). Ultimately, it was found that /i/ was more fronted in English for all but two speakers. The fact that the majority of speakers exhibited this directional difference indicates a more universally accepted fronted /i/ value in English as compared to German. This is also reflected in the values reported by Hillenbrand et al. (1995) as compared to those reported by Pätzold and Simpson (1997). Similarly, all speakers with the exception of speaker 10 have a more fronted production of /ɪ/ in English than in German (reflected in the statistically significant findings presented in Table 7). Again, this was reflected in the average values presented for both German and English, used in the monolingual comparison of this study. These similarities, reflected in the average values calculated for all speakers, are shown in Figure 6.

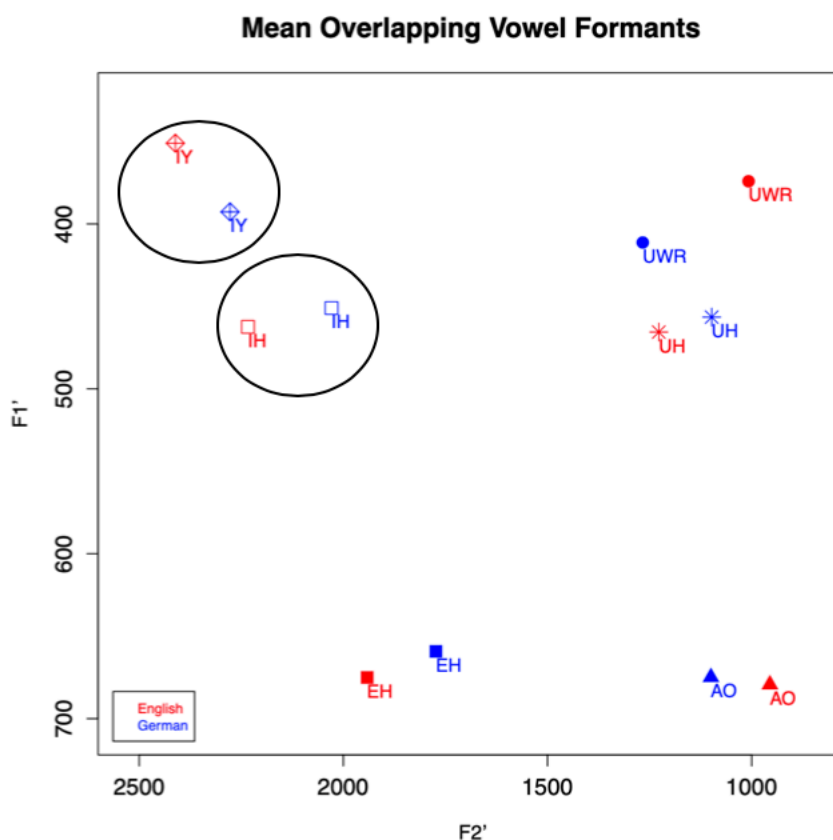


Figure 6. Average F1 and F2 values for overlapping vowels across German and English.

Both of these vowels are in high and front, with /i/ as a reported corner vowel. This relatively universal difference among speakers is not shared among all vowels, which presented more split productions when compared between German and English. Speakers' productions of /ε/, for instance, were lower in English than in German among five speakers, whereas they were higher for the remaining six. Furthermore, five speakers have more fronted productions of /ε/ in English, a difference not reflected in the other speakers. Differences in values for /ɔ/ also differed among speakers, with seven having lower productions in English than German and the remaining four having more backed productions in English. /ʊ/ was one of the vowels that exhibited a statistically significant difference between language-specific productions in terms of average values of all speakers. This is reflected in the fact that eight speakers exhibited a lower and more fronted production of /ʊ/ in English than in German. However, this was complicated by the fact that the remaining three all showed a higher production of /ʊ/ in English. Finally, productions of /u/ were some of the most dissimilar across all speakers; speakers 1 through 6 all produced this vowel in a much more backed manner in English than in German, whereas speakers 7 through 11 demonstrated the opposite difference in which /u/ was much more fronted in English than in German. This disparity is reflected in Figures 7 and 8.

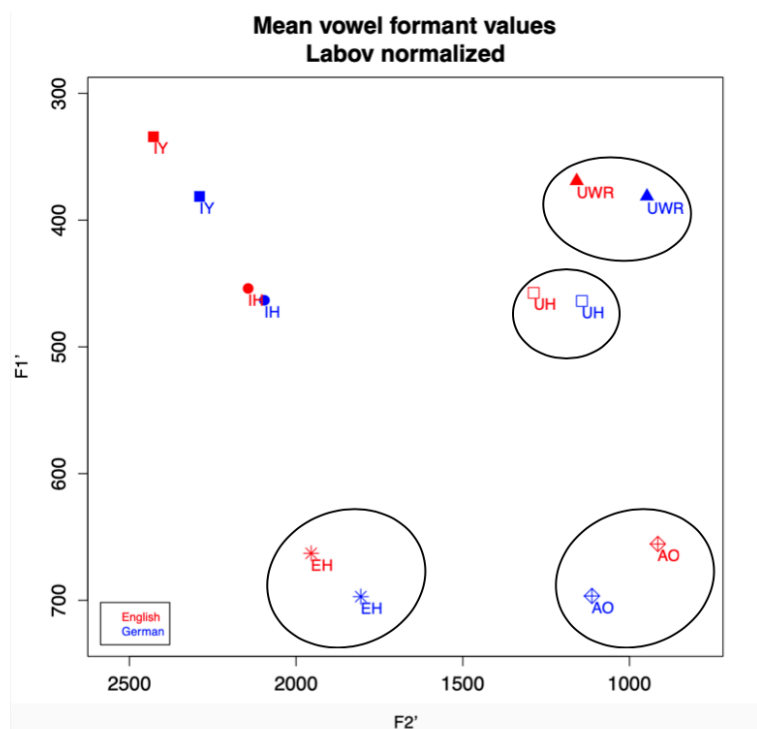


Figure 7. Language-specific differences between cross-linguistically similar vowels, speakers 1-6.

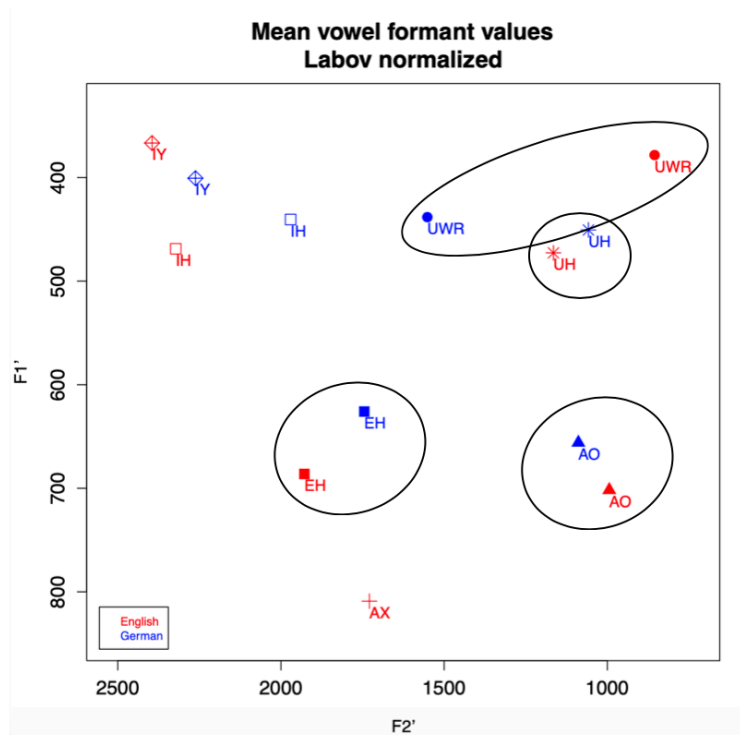
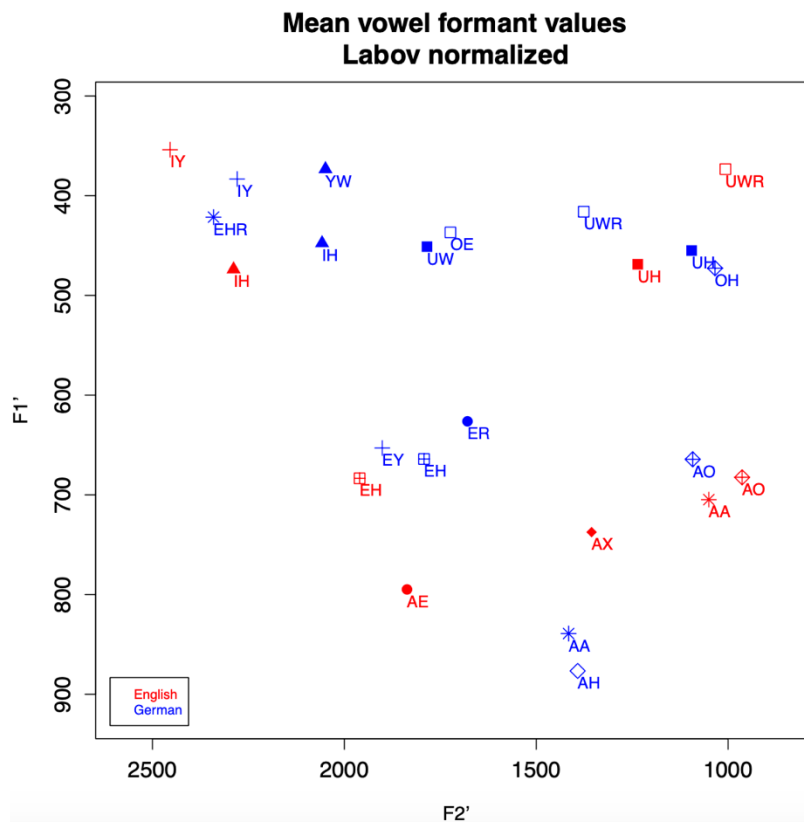


Figure 8. Language-specific differences between cross-linguistically similar vowels, speakers 7-11.

In addition to those vowels that exist in both German and English, vowels that only exist in German or English were also examined in order to examine placement of each vowel, specifically with respect to extralinguistic factors such as speakers' age of acquisition of English. A vowel plot illustrating the complete vowel space for all vowels measured in each language, averaged across all speakers, is shown in Figure 9.



factors including age of acquisition of English, length of time learning English and living in an English-speaking environment, conflation with other language(s) spoken, and alignment of identity with English and/or German. These factors will be considered in the discussion section of this paper.

Discussion

The primary goal of this study was to investigate whether language transfer effects were taking place among native speakers of German who learned English as their second language. More specifically, this study focused on phonetic differences cross-linguistically, using vowel systems as a measurement of degree and directionality of interaction. Because only vowel systems were investigated, the results apply only to vowels and cannot explain the entire linguistic system.

Two types of comparisons were conducted in consideration of speakers' vowel systems: a monolingual comparison, in which reported data from the literature were used as a point of reference from which to examine data from the current study; and a bilingual comparison, in which cross-linguistically similar vowels were compared to one another, both at an individual and a group level including all speakers, in order to ascertain whether speakers were engaging in assimilatory or dissimilatory patterns. Ultimately, six vowels were considered cross-linguistically similar due to their shared IPA symbols: /i, ɪ, ε, ɔ, ʊ, u/. With the exception of /ɪ/ and /ʊ/, speakers were, on average, assimilating all overlapping vowels. These two vowels in particular are produced with more fronted qualities than their German counterparts.

This general movement forward aligns with research on high back vowel fronting, which has been found to be physiologically and acoustically more common than front vowel backing

(Harrington, Hoole, Kleber & Reubold, 2010). This process is reflected in /u/-fronting in American English, a sound shift in which the F2 value of /u/ is increasing dramatically as speakers' productions of /u/ are produced farther and farther forward (Fought, 1999). Although this sound shift originated in California, it is a general pattern of change taking place over time in American English. This difference may, in part, be attributed to this sound change. All speakers have resided in an American English-speaking environment for some period of time, although this varies greatly among participants (ranging from 3 months to 35 years). However, this does not account for the fact that /u/ is not produced significantly differently for each language (keeping in mind that the current analysis only considers average values; more specific data will be analyzed in what follows). Regardless of the exact motivation for the change, which probably varies on an individual basis given the limitations of this study, it is nonetheless a case of dissimilation. In terms of mean speaker values, however, the relatively similar productions of these vowels in each language align with Flege's (1995) Speech Learning Hypothesis, which states that those sounds in a speaker's nonnative language which are most difficult to master are cross-linguistically similar. This is because the target production values have very similar counterparts in speakers' native language.

Ultimately, speakers' vowel productions for the overlapping vowels considered were fairly inconsistent. As far as extralinguistic factors are concerned, it is illogical to generalize across such a small data set. Perhaps most puzzling is the disparity between speakers who fronted their production of /u/ in English and those who backed it. There are no clear criteria delineating why speakers 1 through 6 produce this vowel so dramatically different from speakers 7 through 12. It is unclear why, after having lived in an American English-speaking environment, specifically one in California, only certain speakers would engage in /u/-fronting.

However, because speakers have such diverse backgrounds including not only age of acquisition and length of residences in both German- and English-speaking environments, they also differ in their bilingual backgrounds. Speaker 1, for instance, speaks Russian fluently. Almost all speakers reported either having been instructed in or having the ability to speak a third language, a variable that could not be controlled for in such a limited population. Nonetheless, this variable is just one example of the confounding effects that exist in the current data.

One potential motivating factor for this contrast is Dispersion Theory (Liljencrants & Lindblom, 1972). This theory is based on minimizing the risk of misperception, therefore favoring vowels that are maximally dispersed throughout the vowel space. Perhaps in an effort to be correctly perceived, some speakers are not engaging in this fronting pattern in order to distinguish not only their English from their German, but also to distinguish all of their vowels from one another in an otherwise very crowded vowel space. This dispersion of vowels is seen especially drastically in Speaker 1, who has an extremely wide range of F2 values.

Dispersion Theory (Liljencrants & Lindblom, 1972) is a useful model to consider because the vowel inventories of English and German are quite different, with German containing almost twice as many monophthongs. It may also account for the fronted productions of English high front vowels /i/ and /ɪ/, exhibited in Figure 6. It appears that speakers are pushing these vowels into an otherwise unoccupied area, perhaps in an attempt to distinguish them from others in a crowded vowel space. Because German has such an extensive vowel system, there is less room for large ranges of articulation with respect to each vowel as compared to English, which has a much more dispersed vowel space due to its relatively simpler vowel system. Therefore, one may expect to see greater variation in the articulation of English vowels because the chance of misperception is far lower than it is in German. This aligns with the findings of

Bradlow (1994), who proposes a language-specific base of articulation for a speaker's vowel space.

An additional level to consider is each language's phonology. German contrasts between high front rounded and high back rounded vowels. This would suggest that /u/ would be backed in German in order to accentuate this contrast with its fronted counterparts /ʏ/ and /y/. However, this is only reflected in speakers 7 through 11, further complicating the analysis.

As mentioned above, all participants have resided in an American English-speaking environment in California at least for some portion of their residence in an English-speaking environment. Therefore, speakers' vowel spaces with respect to the California Vowel Shift are relevant, in which /u/, /ʊ/, and /oʊ/ are fronted; /ɔ/ and /ɑ/ are lowered and raised, respectively, to merge in a case of assimilation. Consequently, /æ/ is shifted into /a/'s original position or switched in position with /ɛ/, and /ɪ/ is lowered into /ɛ/'s former position (Podesva, D'Onofrio, Van Hofwegen & Kim, 2015). This movement is illustrated in Figure 10.

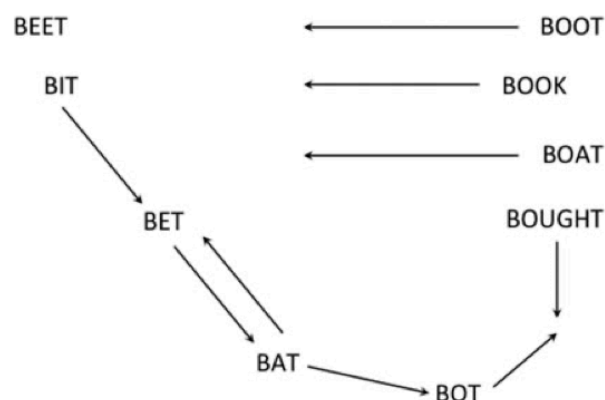


Figure 10. Illustration of the California Vowel Shift.

This study sought not only to examine whether speakers' overlapping vowel spaces were assimilating or dissimilating, but it also considered extralinguistic variables such as age of acquisition of English to evaluate which of these processes were being employed. It was

predicted that speakers with lower ages of acquisition would engage in more dissimilation, resulting in distinct, language-specific productions of each vowel. This hypothesis is based on Flege's (1995) finding that speakers with lower ages of acquisition are better able to discern phonetically similar sounds from one another. In alignment with this theory, it was predicted that speakers with higher ages of acquisition would engage in more assimilation, resulting in merged phonetic categories where vowels are similar cross-linguistically. This hypothesis generally aligns with the Critical Period Hypothesis (Penfield & Roberts, 1959), which identified an age window in which speakers are best able to acquire a language, basing itself on a linear model of age as it relates to language acquisition. However, this hypothesis has been criticized on a number of levels, arguing that it is an oversimplification of language acquisition and that it just is not possible to completely control the amount of time and quality of speakers' L2 acquisition. This argument is reflected in the current study; when asked their age of acquisition of English during interviews, many speakers reported receiving initially basic lessons in elementary school, but not learning anything intensively until they were over the age of 10. This then becomes a difficult variable to analyze due to its subjectivity.

Limitations

As alluded to, there are numerous limitations to this study that have hindered the certainty with which analyses can be conducted. Only 11 speakers were involved, yielding wildly inconsistent results due to inconsistent demographics. Of the speakers interviewed, while the majority were from Germany, four were from Austria and one was from Switzerland. The fact that participants speak German does not imply that they speak Standard High German, as the language contains numerous dialects that differ significantly from one another. And as discussed

earlier, many speakers reported being fluent in a language other than English or German, with one speaker having been born and raised in Portugal.

The lack of original data from monolingual speakers of German and English is another limitation that severely impaired the chance for a statistical analysis of the monolingual comparison. This limitation means that the design of the current study did not yield itself well to an evaluation of phonetic drift because there was not an accurate point of comparison which to evaluate the data from bilinguals. A general visual analysis of the data indicated that speakers' vowels are tending towards the average values for each language. However, further research involving direct monolingual comparisons is required in order to make concrete claims.

Furthermore, only formal speech was analyzed, which has been shown to exhibit fewer transfer effects than exist in casual speech. Speakers were careful in their elicitation of each vowel, producing data that is only reflective of speakers' vowel systems in their most formal states. Therefore, this study is limited in its analysis of speakers' vowels as it does not consider casual speech, which occurs far more often than formal speech.

Future Directions

There are a number of future directions that this study could take. The addition of data from monolingual speakers would provide a more accurate point of reference to which the bilingual speakers' vowel systems can be compared. This would create the opportunity to examine whether (and the extent to which) phonetic drift is occurring. Additionally, limiting region of origin of participants would eliminate many confounding effects, the extent to which are unknown in the current study.

The case of /u/ is particularly puzzling and presents a case for further research, due to how strong the contrast is between speakers who produce it with a high F2 and those who produce it with a low F2. But, to conduct further research on this would require more participants, involving an analysis of linguistic and extralinguistic variables on speakers' productions of /u/. A consideration of the phonology of individual speakers' dialects may also yield insight into this pattern.

As mentioned in the limitations section, a consideration of only formally elicited speech disregards transfer effects that may be occurring at a more colloquial level. Including informal speech in this analysis, and perhaps designing a portion of data collection for this type of speech (such as with the Rainbow Passage (Fairbanks, 1960)) would be an interesting level of analysis. Speakers were very careful in their elicitation of each word, whereas in casual speech, they were more at ease to speak. In casual speech, vowel reduction is more likely to occur because there are more unstressed environments (Crosswhite, 2004). Therefore, a large selection of speech would be required in order to obtain all vowels in stressed environments and this further research may yield findings not indicated in the present study.

Extralinguistic factors could have larger implications, possibly in explanation of speakers' vowel data. As evidenced by Fought's (1999) study in which she found that members of a minority community were engaging in a sound change initiated by the majority community, speakers have a tendency to engage in sound changes that are prevalent in the community in which they live. Not only does location of residence factor into this, but speakers' perception of and attitudes towards their community play an influential role as well. Almost all speakers struggled to answer the question of where they consider home, responding with a diversity of places. For instance, speaker 10 reported not feeling completely at home in the United States or

in Austria. This alienation and sense of exclusion from a home community may factor into language transfer observed as well; perhaps speakers who reported immediately feeling at home upon entering the US engage in more native-like speech in English than those who still feel most at home in Europe. As with all other factors mentioned, this analysis would require further research and isolation of variables. And although the limitations of this study constrained statistical analyses of phonetic drift, it can't be ruled out altogether; some speakers mentioned others interpreting their German speech as "Americanized". Perhaps, then, a perception study would be useful here in addition to further production studies, in order to evaluate both ends of the communicative sphere. Needless to say, the current study exemplifies the need for analyses of cross-linguistic transfer effects on a number of levels, underscoring the complexity of speakers' linguistic systems as they are influenced by both linguistic and extralinguistic factors.

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Appendix A

ARPAbet to IPA Translations

IPA	IPA Transcription		ARPAbet	ARPAbet Transcription	
	English	German		English	German
/i/	/hid/	/bitən/	IY	HH IY D	B IY T AX N
/ɪ/	/hɪd/	/bitən/	IH	HH IH D	B IH T AX N
/ɛ/	/hɛd/	/betən/	EH	HH EH D	B EH T AX N
/ɔ/	/hɔd/	/bɔtən/	AO	HH AO D	B AO T AX N
/ʊ/	/hʊd/	/bʊtə/	UH	HH UH D	B UH T AX R
/u/	/hud/	/ʃputən/	UWR	HH UWR D	CH P UWR T AX N
/ɑ/	/had/	--	AA ⁶	HH AA D	--
/a/	--	/hatən/	AA	--	HH AA T AX N
/æ/	/hæd/	--	AE	HH AE D	--
/ʌ/	/hʌd/	--	AX	HH AX D	--
/e/	--	/betən/	EHR	--	B EHR T AX N
/ɛ:/	--	/bɛ:tən/	EY	--	B EY T AX N
/y/	--	/hytən/	YW	--	HH YW T AX N
/ʏ/	--	/hytən/	UW	--	HH UW T AX N
/ø/	--	/gøtə/	OE	--	G OE T AX
/œ/	--	/gœtə/	ER	--	G ER T AX R
/a:/	--	/ba:tən/	AA	--	B AH T AX N
/o/	--	/botən/	OH	--	B OH T AX N

⁶As indicated, AA reflects IPA symbols /ɑ/, /a/, and /a:/. This is simply due to a lack of variation in standard ARPAbet conventions, but is not relevant to interpretation of results for the current study because these vowels are not evaluated as cross-linguistically similar due to their reported distances in the average vowel space.

Appendix B

Sociolinguistic Interview Questions

1. Where are you from and how long did you live there?
2. Have you lived anywhere else besides Germany/Austria and the United States?
3. At what age did you begin to learn English?
4. At what age did you move to an English-speaking environment?
5. How long did you live in a German-speaking environment?
6. What is the ratio of German to English use that you employ on a daily basis?
7. What language do you speak with members of your family?
8. Where do you consider home?
9. Before learning English, did you have any strong opinions of it or the people who spoke it? If so, what did you think of it?
10. Before learning English, what was your media consumption like (i.e., how much media were you exposed to daily)?
11. What is your media consumption like now?
12. Do you ever notice any influences of your German on your English, or your English on your German?
13. What is your comfort level speaking, reading, and writing in each language?